thrix, Fucus, Peronospora. The higher support dependent sporophytes, e. g., Œdogonium, Marchantia, Sphagnum. The highest are symbiotically parasitic upon sporophytic structures of their own species, e. g., the Isoetineæ, Selaginelleæ and Siphonogama. These might be named respectively the Protogamophyta, Eugamophyta, and Metagamophyta. It is this last division that constitutes the principal part of the unexplored region. The accompanying diagram indicates the grouping of living things here suggested.

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Some fungi common to wild and cultivated plants.

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Reference is here made to the relation of the fungous parasites of wild plants, including weeds, to our crops whether of fruit, grains, or vegetables. This deleterious influence can best be brought out by taking up some of the worst fungous enemies to crops and showing the range of these parasites upon the surrounding wild plants.

Starting with the garden vegetables it is easy to find illustrations on every hand. Thus the lettuce mildew, *Bremia Lactucæ* Reg. is found up to date upon no less than forty-one species of plants belonging to the same family as lettuce and closely related to it. Many of these hosts for the mildew are common garden weeds and others inhabit the uncultivated ground.

The celery rust, *Cercospora Apii* Fr. now so destructive with truckers, is common to the carrot and parsnip also, and as the wild form of these abound without stint in many localities we need not wonder that the garden plants are partially destroyed by this pest.

There is a mildew of the spinach, *Peronospora effusa* Gr. that flourishes upon the pigweeds generally, there being no less than ten of these weeds that are thus infested and furnish a propagating place for the mildew of their patrician cousin grown on a salad plant.

The bean rust, *Uromyces appendiculatus* (P.) is one among a conspicuously destructive group of fungi that makes its home upon several species of wild beans.

But of wider range than any species yet mentioned is the mildew of the pea, *Erysiphe Martii* Lev. which renders it almost impossible to grow late peas. This fungus preys upon plants of at least six large and quite widely separated families and therefore in any neighborhood may have ample means at hand for keeping up its abundant stock of specimens.

The mildew of the cabbage and turnip, *Peronospora parasitica* (P.) is not an unmixed evil however, for because of its wide range it attacks the shepherd's purse, various mustards, and a number of other weeds. The hosts enumerated in a list recently consulted were thirty-five, and most of these are common plants in all parts of our country. Another fungous disease of the cabbageand turnip, namely, the club root, *Plasmodiophora Brassicæ* W. while as yet not recorded outside of these two hosts and the radish, very likely is at home with many of the other plants of the same order, but root diseases being out of sight are not easily found unless specially looked for.

Coming to the fruits and beginning with the lowest in stature, the cranberry, we see a fine instance of the question in hand in the gall fungus, *Synchytrium Vaccinii* Th. The following, mostly small shrubs growing along the shore or border of the bog, are afflicted with the same disease: azalea, sheep laurel, white alder, leather-leaf, huckleberry, and wintergreen. While these plants are members of the same family, they all differ considerably from each other and from the cranberry. It is evident that any remedy applied to be effective would need to include the infested shore shrubs.

The strawberry blight, *Sphærella Fragariæ* (Tul.) is met with upon wild vines of both our common species.

Sphærotheca Mors-Uvæ (Sch.) producing the gooseberry mildew and crippling an industry in this country, is found upon several species of our wild gooseberries. The writer recalls collecting fruit and young twigs entirely covered with the thick brown felt in the cañons of Colorado, where there were no cultivated bushes perhaps within five hundred miles. In like manner the anthracnose, *Glœosporium Ribis* (Lib.) that causes the premature dropping of foliage, is common to several species of currant.

The blackberry rust, *Cæoma nitens* (Sch.) is an especially important illustration of the relationship of wild plants to those close of kin that are cultivated in the garden. This conspicu-

ous rust grows upon the low blackberry, dwarf raspberry, thimbleberry, wild red raspberry, high blackberry, and sand blackberry. In a trip through the Carolinas in May last, this orange colored fungus was to be seen at nearly all times from the car window and one could but pity the cultivated species of Rubus, were there any grown in that afflicted region.

The diseases of the grape and in particular the mildew, *Plasmopara viticola* (B. & C.) are in general common to all wild species of the vine. The worst specimens I ever found were those of a wild plant in Iowa, many miles from any cultivated vines and the mildew was so bad upon the canes as to dwarf them to a few inches in length while they were covered from one end to the other with the white down of the fungus. Not only the *Vitis æstivalis*, *V. Labrusca*, *V. vinifera*, *V. riparia* and *V. Californica* are infested, but likewise the closely related Virginian creeper and more recently the Boston ivy are victims.

Among the plums and cherries we find four parasitic fungi to interest us in this connection, for they abundantly illustrate the fact of the close relationship of wild with our cultivated plants. First the plum pockets, *Exoascus Pruni* (Fcl.) are familiar to all as peculiar distortions of the fruit and stems of the cultivated plum, dwarf cherry, bird cherry, choke cherry, and some other species of the genus Prunus. The peach curl, *Exoascus deformans* (Berk.) also infests the dwarf almond, common garden plum, and three kinds of cherries, besides the peach. There is a rust, *Puccinia Pruni* Pers. which is very destructive in some parts of the country particularly to the peach and apricot in California. No less than ten species of the genus Prunus are subject to attacks from this enemy and the list includes the peach, apricot, plum and cherry, several of the last two being wild trees or shrubs.

Last but not least for the genus Prunus is the black knot, *Plowrightia morbosa* Sacc. As this enemy is of great magnitude it merits the naming here of the eight species that are subject to attack ; namely, the Chickasaw plum, *P. Chicasa* Michx. ; the beach plum, *P. maritima* Wang., a thorny shrub on the sandy sea-shore; the wild yellow plum, *P. Americana* Marsh., a shrub or small tree along streams. Of the cherries, the choke cherry, *P. Virginiana* L., a small tree, is most frequently infested; but the wild black cherry, *P. serotina* Ehrh.,

a tree of the hedge rows, and the wild red cherry, *P. Pennsylvanica*, are also attacked.

It is evident from the illustrations that have been given of the diseases of the genus Prunus that there must be a close relation existing between the wild plants and those grown for fruit. What with the plum pockets, the curl, rust, and black-knot, it is evident that more attention needs to be paid to the wild hosts of fungi of cultivated plants before the latter can be free from their attacks of their present enemies.

There is a mildew, *Podosphæra tridactyla* (Wallr.) so widespread that it cannot be assigned to any one crop. Because very destructive upon the apple and particularly seedlings in the nursery it has been called the apple leaf mildew, but in some localities cherries, both old and young, suffer severely from it. It preys upon the quince, several species of the hawthorn, the June berry and various spireas. It seems to be a well established fact that plants that are closely related are quite apt to be subject to the same fungous enemies. But it does not follow that plants not near of kin will not have parasites in common. For example, within the past year it has been fully shown that bitter rot or ripe rot of the apple fruit is the same fungus that causes one of the dreaded decays of grapes. In like manner at the New Jersey experiment station it has been found that one of the worst enemies to the sweet potato is identical with a serious disease of egg plants. There seems little in common between the sweet potato and the egg plant and yet in the face of the fact of a common enemy it may suggest the importance of not following one crop by the other in those localities where they are both grown prominently and one or both are already more or less diseased.

In like manner it has been shown that a bacterial disease of the potato also affects the tomato and *vice versa*; and that was to be expected as both hosts are closely related; but that one disastrous form of melon blight is due to the same cause was unexpected because of the lack of kinship between melons and potatoes. The inference was that if melons were attacked cucumbers and squashes would also be. This was shown to be true and before the season was through it was found that much damage to the cucurbits generally was due to the bacterial disease.

Space forbids even the briefest mention of many other cases where plants wild affect the health of plants cultivated

by being the means of supply of fungus germs. One other instance that illustrates a phase of our subject not before touched upon may be given. The plant is a familiar one to many and painfully so to not a few. This is the apple rust (*Rœstelia*) that yellows the foliage of the orchard in July and shortens the crop at picking time. This fungus plays a double role and seems unable to get along with the apple tree alone. In a second and very different form, *Gymnosporangium*, it infests the cedar trees, there forming knots or galls that become conspicuous as gelatinous balls during the spring rains. These orange colored balls furnish the spores, which falling upon the foliage and fruit of the apple tree, produce the fatal rust. Later in the season the spores from the apple fungus go back, upon the wings of the wind, to the cedar and a new crop of galls is obtained for next spring's campaign against the orchard. In this case it is not wild apple trees or those of the same family that harbor the enemy, but a tree as widely separated botanically from the apple as is well possible. More than this, the fungus changes its form in passing from one to the other so that it was not until demonstrated by actual cultures that the relation, long suspected, could be fully believed. It is needless to say that the very evident method of procedure is to destroy cedar trees that are anywhere near the apple orchard. A single large gall-bearing cedar tree just outside the orchard fence may do more mischief than any enemy that is lurking within the enclosure.

It has been shown by means of a long series of examples that the evil influences of wild plants may act at long range. It is not necessary that their roots and those of the cultivated plants hould cross each other's paths in the soil or that their branches should interlock and overshadow one another in a deadly embrace. There is a more subtle bad influence than gross thieving or clutching by the throat. It is more in the nature of a poison that is sent out upon the air to be breathed in by the innocent wherever they may unwittingly meet the unseen but de ıdly germs.

Crowding of plants is bad, rank growth of weeds is worse, but the most fatal of all influences is that unseen group that steal away the health of the plants which lack nothing for room and enjoy high and thorough culture.

After all it is the host of enemies that swarm from the

plants outside the garden fence that try the patience of the husbandman. He has learned the methods of remedying the others, but the floating spores defy his keenest eyesight to discern and baffle his ingenuity to combat. The ways of the fungi are however being slowly and laboriously revealed by the microscope and conquered by the spraying pump. The former assists the latter, which as yet somewhat blindly fires effective "small shot" into the enemies ranks.

Proper seeding, fertilizing, and weeding will do much to assist, in warding off the deleterious influences of fungous enemies for healthy plants, while not proof against their attacks, are less liable to be overcome by them. Let therefore everything be done that is possible before the last resort comes and then the fungicide will have the greatest effect and yield the most returns. If so much of the smut, rust, mildew, mold, rot, and blight of our cultivated plants is propagated by the wild plants hard by, it may be wise for every crop grower to pay attention to what is thriving outside his garden wall. He cannot build it high enough to shut out the spores, but he can do much to diminish the number of these spores. Having done this, he can take up the spraying pump with a brighter hope of future success. There was a carcass, so to speak, in the pasture and he went out and buried it. Fungi are the basis of contagion and they infect at long range by means of their myriads of invisible spores. To learn of their ways and find better methods of resisting them make the burden of many a station botanist's labor today.

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Noteworthy anatomical and physiological researches.

The stem and leaf of the mosses.[1]

After alluding briefly to the principal works on the subject of his research, the author takes up the study of the anatomy of the aerial stem of mosses, distinguishing four types.

I. With uniform parenchyma containing chlorophyll bounded by: 1. A zone of aquatic cells; 1st type, Sphagnum. 2. An epidermal layer; 2d type, Thuidium.

[1] BASTIT, EUGENE: — Recherches anatomiques et physiologiques sur la tige et la feuille des mousses. Revue général de botanique. III (1891.). pp. 255, 306, 341, 373, 406, 462, 561.